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ARMSTRONG LABORATORY

EVALUATION OF WATER QUALITY-- HOWARD AFB, PANAMA BACTERIOLOGICAL QUALITY

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OCCUPATIONAL AND ENVIRONMENTAL
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Brooks Air Force Base, Texas 78235-5000

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Final Report

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The 24th Med Gp/SG through HQ TAC/SGP requested the AFOEHL visit Howard AFB for consultation on bacteriological monitoring procedures and to evaluate whether the water supply met Safe Drinking Water Act standards.

The base was complying with most accepted practices for bacteriological examination of water using the membrane filter technique. The report makes eight minor recommendations concerning sampling including speciation of all colonies, positive before negative control samples, and four follow-up samples at each positive site.

US drinking water regulations fit the Panamanian-supplied water situation poorly. The report recommends US-Panamanian combined sampling to evaluate compliance or, alternatively, a US-USA combined evaluation. It also recommends USA and US medical personnel provide SOUTHCOM and HQ TAC monthly epidemiological and water sample results as long as samples show coliform in the distribution system above US limits, and that SOUTHCOM/SG decide whether water-related disease rates warrant public notification.

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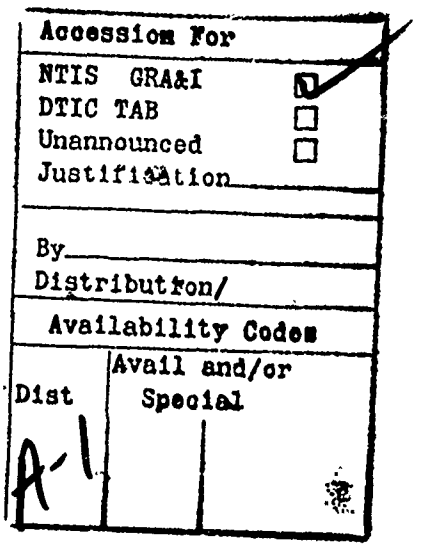

Contents

I. INTRODUCTION

Purpose: 24 Med Gp/SG through HQ TAC/SGP requested the AFOEHL visit Howard AFB for consultation (Appendix A). The purpose was to review the Howard AFB Bioenvironmental Engineer's bacteriological monitoring procedures and to evaluate whether the base was complying with the Safe Drinking Water Act (SDWA) regulations for coliforms. Howard's BEE office was complying with Air Force (1) and Standard Methods (16) procedures for bacteriological examination of water using the membrane filter technique. The base was complying with the monitoring requirements of SDWA. The coliform levels in the drinking water in Howard AFB's portion of the distribution system met EPA standards; however, this report recommends the Air Force BEE and the Army Preventive Medicine Service compile their bacteriological results for the purposes of determining compliance.

Problem: In recent months there has been concern about the quality of the drinking water in Panama. USA Preventive Medicine (PM) Service had identified coliform contamination in a number of drinking water samples. Increased chlorine dosage levels by the Panama Canal Commission (PCC) did not immediately eliminate coliform contamination. PCC samples and Air Force BEE sampling results did not show contamination. The most common coliforms PM identified were Enterobacter and Klebsiella.

Scope: This report reviews and recommends minor changes to the bacteriological monitoring procedures of the BEE office at Howard AFB. It also describes the applicable water quality regulations and provides technical information on distribution system biofilms which are a potential source of the present problem.

Maj John G. Garland III conducted the on-site visit 11-15 Sep 90. He contacted the following key personnel:

Col Meyer, 24th Med Group Commander
Col Diffley, USAF SOUTHCOM Civil Engineer
Maj Chandler, USA MEDDAC Chief PM Service
Sgt Allen, PM Technician
Lt Col Skalka, 24th Med Group Chief Environmental Health
Cpt Harvey, 24th Med Group Bioenvironmental Engineer
Sgt Harrington, 24th Med Group Bioenvironmental Engineering Technician
Mr Tom Runyon, AEHA Engineer
Dr John Brokow, AEHA Microbiologist
Mr Jose Lara, PCC Water Treatment Plant Engineer

II. DISCUSSION

A. Introduction

The Miraflores Water Treatment Plant serves US Forces as well as Panamanians. The Figure shows a line diagram of the major water lines in the

Note: This report was accomplished by the Air Force Occupational and Environmental Health Laboratory (AFOEHL), which is now the Armstrong Laboratory, Occupational and Environmental Health Directorate.

distribution system servicing US Forces. The distribution system is made of cast iron, concrete and some PVC. Portions of the distribution system are 70 or 80 years old. Ft Clayton's branch of the distribution system receives their water either directly from the pump station or in the reverse direction from a storage tank. The Miraflores Water Treatment Plant fills the tank at Clayton using pressure as high as 100 psi, then shuts the flow off to that branch of the system. The tank then supplies water to the system with water pressure in the opposite direction of 30-40 psi. Panama, for practical purposes, has two seasons: a fall and winter rainy season with daily precipitation and a dry summer season. Panamanian nationals working on military installations provide the principal day-to-day interface between the Panamanian and US communities. The Air Force requires all personnel to live on base. The Army allows a limited number of personnel to reside off-post.

The Miraflores plant treats water by prechlorination, aeration, powdered activated carbon addition, rapid mix, flocculation, filtration and gas chlorination. The primary source of water is the Panama Canal near Paraiso.

The Panama Canal Commission (PCC) manages the Miraflores Water Treatment Plant. They are not required by Panamanian law to produce water which meets US EPA standards. Water quality can be prescribed to some extent by agreement between US forces and the PCC.

Agreements with Panama call for transition of control of the PCC to the Panamanian government and gradual reduction of the US military presence in the future.

B. Howard AFB Bacteriological Monitoring Procedures

The 24th Med Group, Bioenvironmental Engineering office performs bacteriological monitoring using the membrane filter technique following Standard Methods (16). They collect samples on a weekly basis from either four or five sample points that are representative of the major loops in the distribution system at Howard AFB, Albrook AFB, and at a well which provides water to the MMS organization at Howard AFB. Technicians in the past took the MMS sample at the well house from a tap in a 1000 gal water tank. At Maj Garland's recommendation the sample was taken in the MMS administration building at the tap where the office makes coffee.

The technician typically begins the water run on a Monday morning at 0800 and finishes collection by 1200. The technician collects samples in whirl pack plastic containers pretreated with sodium thiosulfate and places them in a wire basket containing ice packs. Standard Methods recommends storing samples in an ice cooler if they cannot be processed within one hour of collection. Technicians should hold sample temperature at 10°C. Maximum transport time should be under six hours.

The technician usually samples from an exterior tap and allows the water to run two minutes before collecting samples for free available chlorine and pH analysis. Approximately two minutes later the technician opens a whirl pack, collects a sample, seals the sample, and places it into the wire basket with the ice packs. The technician collects a positive control sample from a surface stream on Howard AFB and places the samples in a refrigerator until preparation.

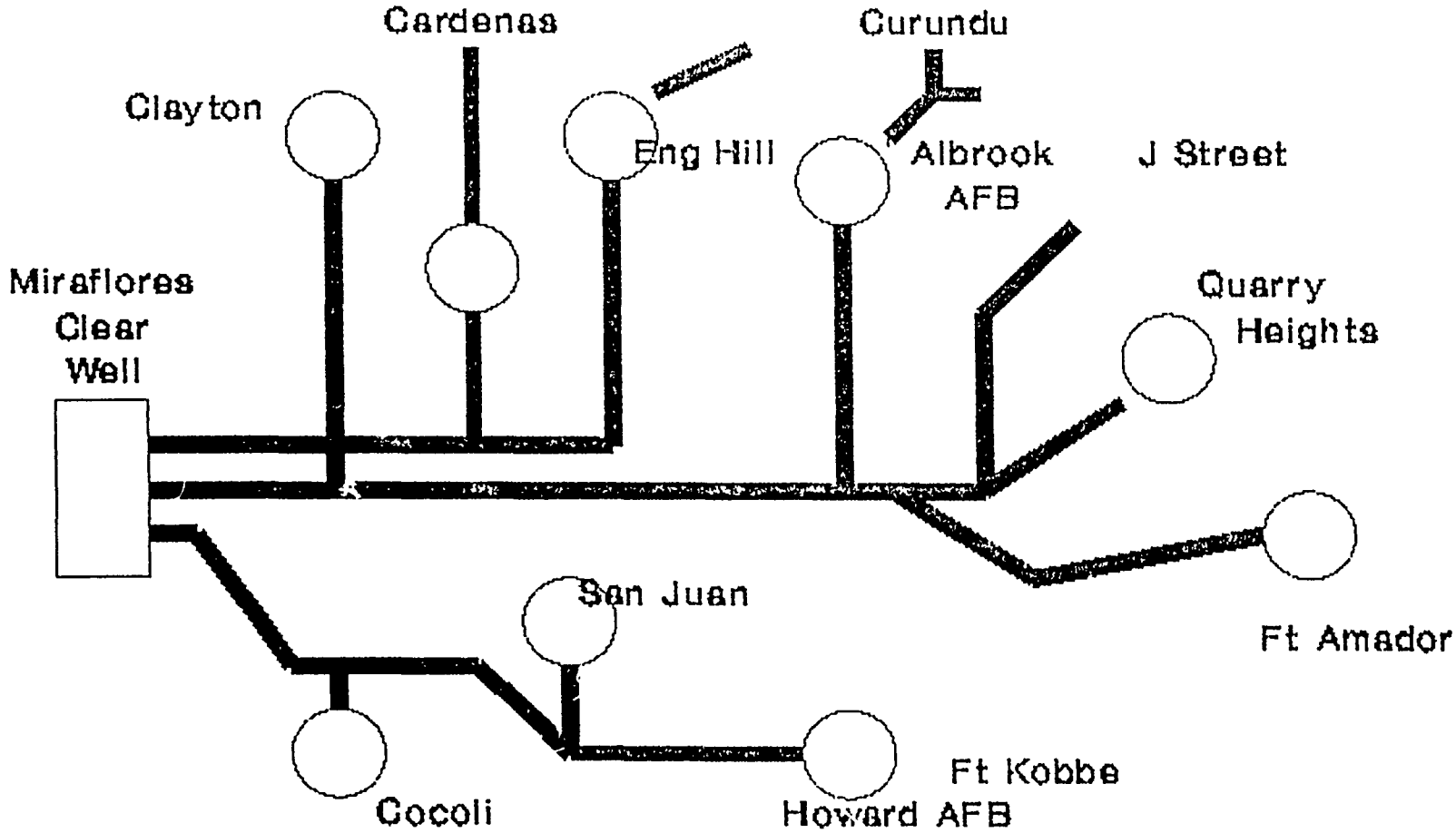

Figure. Miraflores Water System Line Diagram

In late morning or early afternoon the technician prepares the samples for incubation. The office uses disposable plastic culture dishes, a glass filter-holding assembly sterilized before use by the clinic laboratory, a 1-liter filtering glass with side tube connected to an electric vacuum pump. The office has fresh stocks of pre-sterilized membrane filters and adsorbent pads. The technician removes pads from their packaging using forceps sterilized by dipping in alcohol and flaming. The office uses refrigerated sterile ampules of commercially prepared endo-type media. The technician places a pad in each petri-dish and adds--then drains--excess media. Using sterilized forceps, the technician places a filter on the filter-holding assembly, reconnects the upper receptacle, pours 100 milliliters of sample into the receptacle, turns on the filter pump, and filters the sample. The technician then pours sterile rinse water from a liter container into the receptacle and swirls the entire filter apparatus in a circle to wash the interior of the receptacle. Once the pump has pulled the rinse water through the filter, the technician turns the pump off, removes the filter using sterilized forceps, resterilizes the forceps, and places a new filter onto the filter apparatus. The filtered sample is placed with a rolling motion onto the media pad.

Controls. The office uses a sequence of samples and controls as follows: negative control, samples, negative control, positive control. The technician created negative controls by using 100 ml of distilled water. The positive control was created by using 5 ml of stream water and 95 ml of distilled water. At Maj Garland's recommendation, the technician used the following sequence: negative control, samples, negative control, samples, positive control, negative control.

Following preparation, the technician places the petri-dishes upside down in an incubator at 35°C for 22 to 24 hours. The samples are evaluated under a circular magnifying lens surrounded by a fluorescent light source. In the past the BEE has reported only green sheen colonies as positive coliforms. Recently the office implemented a policy to speciate all colonies--regardless of color--and atypical growth through the clinic laboratory. The office does not have a policy to conduct additional sampling if results show coliform. The BEE evaluates and records results.

Standard Methods 17th edition (16) defines coliform as applied to the membrane filter technique as "all aerobic and facultative anaerobic, gram-negative, nonspore-forming, rod-shaped bacteria that develop a red colony with a metallic sheen within 24 hours at 35°C on an Endo-type medium containing lactose. When purified cultures of coliform bacteria are tested they produce a negative cytochromeoxicase (CO) and positive B-galactosidase (ONPG) reaction. Generally, all red, pink, blue, white, or colorless colonies lacking sheen are considered noncoliforms by this technique." Standard Methods (16) (pp9-83) also recommends verifying all types of sheen and non-sheen colonies using CO/ONPG since coliforms occasionally may produce atypical colonies.

C. Sample Results

1. Howard AFB Results

a. Appendix B shows the SGPB water results logbook for part of Jul 90 and for Aug 90. Remarks prior to Sep 90 indicating "no growth" mean no green sheen growth. Speciation and identification of non-green sheen growth as potential coliform began in Sep 90.

(1) MMS samples come from well water rather than the PCC. Three samples averaged 1.2 mg/l (range 1.0 to 1.5 mg/l) free available chlorine (FAC). Average pH was 7.3 (range 7.0-7.6). Two of the three shown in the 6-week log produced colonies--one sample produced one Enterobacter colony and one sample produced one Acinetobacter (non-coliform) colony.

(2) Munitions maintenance samples reflect the water quality in the storage tank adjacent to the well.

b. The data show Howard AFB took 19 samples in Aug 90 excluding controls and special samples taken in conjunction with the USA PM office. The base typically would take less than 20 samples a month for the portions of the distribution system serving Howard AFB and Albrook AFB. No coliforms were identified (two samples 165 and 168 showed Acinetobacter--not coliform). The pH ranged from 6.8 to 7.4 with an average of 6.9. Free available chlorine ranged from 1.0 mg/l to 3.0 mg/l with an average of 2.3 mg/l. Sample 177 at Fleet Services showed no chlorine residual. This sample was in a holding tank sample and not representative of the distribution system.

c. The Howard AFB BEE office had limited THM data. An Oct 83 sample showed the munitions maintenance well to have a maximum trihalomethane potential of 41.7 ug/l. A Mar 82 letter from Howard AFB SGPM to HQ TAC stated 7 samples for total THM at Howard AFB were less than 100 ug/l, 2 samples at Albrook were less than 100 ug/l, and the principal THM was chloroform ranging from 63-73 ug/l (the actual sample results were not available). In Nov 88 base sample 880132 showed 93 ug/l total THMs (86 ug/l chloroform). On 11 and 12 Sep 89 three base samples 890170-172 showed 39 ug/l, 46 ug/l and 46 ug/l, respectively.

2. USA Preventive Medicine Results

a. Appendix C shows the USA PM's bacteriological results for Jun, Jul and Aug 90 as well as a comparison of side-by-side sampling done with the PCC and the Air Force. This record does not identify the number of coliforms found in each positive sample. Appendix C shows free available chlorine levels for each USA sample.

b. The table below summarizes the USA's Aug 90 sampling results:

US Army Panama Preventive Medicine Bacteriological Sampling Summary Aug 90

Location	Total Samples	Total Positive	Percent Positive	Average Free Avail Cl
Clayton	18	10	56	2.5 mg/l
Ft Amador	8	2	25	2.3 mg/l
Quarry Heights	9	3	33	2.4 mg/l
Curundu	6	3	50	2.8 mg/l
West Bank	6	1	17	2.5 mg/l
Total:	47	19	40%	

Note: Curundu follows Albrook AFB on one main branch in the distribution system and West Bank samples include Ft Kobbe which shares a branch of the distribution system with Howard AFB.

D. Regulations:

1. US Drinking Water Regulations. The Safe Drinking Water Act of 1974 and its major amendments in 1986 regulate drinking water quality in the US. The amendments of 1986 required establishing MCLs (primary drinking water regulations) for 83 contaminants with the regulation of an additional 25 contaminants in 3-year cycles beginning in 1991. EPA requires monitoring numerous non-regulated contaminants and there are secondary drinking water regulations effecting taste and odor.

2. Coliform

a. The 40 Code of Federal Regulations (CFR) 141.14 describes EPA drinking water regulation for coliforms. It states that when the monitoring agency uses the membrane filter technique, the number of coliform bacteria shall not exceed either of the following: One per hundred ml as the arithmetic mean of all samples taken per month, or four per hundred ml in more than one sample (for monitoring less than 20 samples a month). Where the monitoring office collects more than 20 samples per month, only 5% of the samples can exceed 4 per 100 ml. The monitoring agency should collect samples at representative points in the distribution system (141.21). EPA requires the minimum number of samples by population as shown below:

6,701 to 7,600	8
7,601 to 8,500	9
8,501 to 9,400	10
9,401 to 10,300	11
10,301 to 11,100	12
11,101 to 12,000	13
12,001 to 12,900	14
12,901 to 13,700	15
13,701 to 14,600	16
14,601 to 15,500	17
15,501 to 16,300	18
16,301 to 17,200	19

(Continued but not shown here.)

b. Follow-up sampling. When the coliform bacteria in a single sample exceeds 4 per 100 ml, the monitoring office will collect at least two consecutive daily check samples from the same sampling point (141.21d1), and continue consecutive daily samples until the results show less than one coliform per 100 ml. Check samples do not count when calculating compliance, nor do samples taken following pipe replacement, etc.

c. Effective 31 Dec 90 coliform regulations changed.

(1) A system will meet the new MCL if fewer than two samples during a month are total coliform-positive for a system collecting fewer than 40 samples a month. Any Escherica Coli or fecal coliform positive sample violates the new MCL.

(2) The minimum number of samples will remain the same. The base must conduct follow-up sampling if a routine sample is coliform positive (i.e., 1 colony per 100 ml, or positive by other test, e.g., Colilert system),

the monitoring office must collect 3 repeat samples within 24 hours of notification of the positive result. One sample must be at the original tap which showed total coliform-positive, one needs to be upstream within five service connections of the contaminated tap and one needs to be within five service connections downstream of the original sampling site (new141.21b2). If any of the repeat samples is total coliform-positive, the monitoring office must collect another set of follow-up samples. The office must repeat the process until they detect no coliforms in one complete set of repeat samples or they exceed the MCL and must notify the state. EPA requires the monitoring office use these follow-up samples when calculating compliance. When the laboratory cannot validate a sample because of confluent growth or too-numerous-to-count growth, the monitoring office must collect another sample from the same location within 24 hours, and continue to re-sample until they obtain valid results.

(3) Another addition effective 31 Dec 90 is the requirement to identify either fecal coliforms or Escherichia coli. If any routine or repeat sample is total coliform-positive, the monitoring office must analyze it for the presence of fecal coliforms or E. Coli. If fecal coliforms or E. Coli are present, the monitoring office must notify the state by the end of the day.

(4) The new regulations contain a revised public notice for total coliform violations and a separate notice for fecal coliform and E. Coli violations. EPA rules require public notification for any of the four following conditions: (1) failure to comply with an MCL, (2) failure to comply with a treatment technique, (3) failure to perform water quality monitoring as required by regulations, or (4) failure to comply with testing procedures (other conditons exist not relevant to this report).

3. Trihalomethanes

a. The maximum contaminant level for trihalomethanes is 0.10 mg/l (40CFR 141.12). It applies to community water systems serving a population of 10,000 or more individuals and which add a disinfectant to the water in any part of the drinking water treatment process.

b. EPA requires sampling for total trihalomethanes at quarterly intervals on at least four water samples. A monitoring office must take at least 25% of the samples at locations within the distribution system reflecting the maximum residence time of the water in the system. The monitoring office must take the remaining 75% at representative locations in the distribution system.

c. EPA bases compliance on a running annual average of quarterly samples.

d. EPA plans to propose new regulations for trihalomethanes in late 1991 with a final rule expected in 1993. The strawman rule calls for a MCL for total trihalomethanes to be either 0.05 mg/l or 0.025 mg/l.

E. Bacteria in Distribution Systems: A series of articles by LeChevallier in Applied and Environmental Microbiology and the Journal of AWWA provide a good overview of bacteria in distribution systems and the associated bibliographies (6,7,8,9).

1. Occurrence & Significance. Coliform levels and species diversity increase as water moves from the treatment plant through the distribution system. In one experiment in New Jersey, LeChevallier was only able to isolate coliforms in iron tubercles. Assimilable organic carbon levels showed carbon levels declining in the water system. Microorganisms colonize most pipe surfaces in distribution systems. Culture examination of distribution system biofilms has demonstrated large variations in the number of heterotrophic plate count (HPC) bacteria including Acinetobacter, Arthrobacter, Flavobacterium, Moraxella, Bacillus, Pseudomonal, Alcaligenes, and Acromobacter (6). Nagy and Olson (14) observed that bacterial density estimated by HPC increase 1 log for every 10 years of service. Coliform are not always associated with distribution system biofilms, nor is their source necessarily caused by breakthrough from the treatment plant.

2. Factors Effecting Survival. In one case in New Jersey, maintenance of a 1.0 mg/l free chlorine residual was insufficient to control coliform. Pigging and flushing were not an effective control for coliform occurrences (6). In exploring the factors associated with promoting survival of bacteria in chlorinated water supplies, LeChevallier (8) concluded disinfection resistance increased with age of biofilm, bacterial encapsulation, and previous growth conditions; increasing resistance to chlorine by 2- to 10-fold. The results of this study (8) show that attachment of bacteria to surfaces provides a means for bacteria to survive disinfection. Ridgway and Olson (15) showed bacteria in chlorinated drinking water were primarily associated with particle surfaces. "Disinfection by free chlorine was affected (reduced) by surfaces, age of the biofilm, encapsulation, and nutrient effects. Disinfection by monochloramine was only effected by surfaces." (8) Biofilm bacteria grown on surfaces was 150 to 3,000 times more resistant to free chlorine than unattached cells while only 2- to 100 times more resistant to monochloramine disinfection (9). A number of major water systems in the US have found combined chlorine/chloramines an effective method of controlling bacterial levels in the distribution system, notably, Denver Water Department and Philadelphia Suburban Water Co. Pickering Creek Plant. In his experiment reported Jul 90, LeChevallier et al., showed biofilms grown on iron pipes treated with free chlorine doses as high as 4 mg/l (3 mg/l residual) for 2 weeks did not show significant changes in viability, but if treated with 4 mg/l of monochloramine for 2 weeks, the biofilms exhibited a 3-log die-off (6). He also sites several references (2,4,5,10) that show traditional practices for distribution system maintenance, including flushing and mechanical cleaning, have been ineffective in control of biofilm problems if the source of the contamination is not eliminated. Martin et al. (12) reports the addition of 5 mg/l lime to raw water caused a 99% reduction in Klebsiella pneumoniae in Nova Scotia where previous application of 3-4 mg/l of free available chlorine residual had not eliminated coliform detection. Donlan and Pipes (3) studied cast-iron test surfaces in a distribution system and showed the population of microorganisms was directly related to water temperature and suspended microbial population density and indirectly related to chloramine concentration and maximum velocity. They showed no relationship between pH, alkalinity, organic nitrogen, ammonia, nitrite, total phosphate, orthophosphate, total organic carbon and attached microbial population density.

III. CONCLUSIONS

A. Bacteriological Monitoring

1. The munitions maintenance sampling point does not reflect the quality of water in either the well or at the tap where it is consumed by unit personnel. Long holding times in the water tank by the well could be the cause of past decreased chlorine residual and some bacterial growth.

2. The combination of high local temperature and delays of from 4 to 6 hours between sampling and refrigeration and filtration create conditions which could result in continued bacterial growth in samples under present procedures.

3. Sample sites in most cases reflect loops or full flowing portions of the distribution system whereas 40 CFR requires sampling points to be representative of the entire distribution system. AFR 161-44, Management of the Drinking Water Surveillance Program (1), paragraph 6-2a(1)(c), states that bases will not collect routine samples from dead-end sections of the distribution system. The BEE has no routine sample collection scheduled for the entry points to Howard AFB and Albrook AFB.

4. The present sample collection practice does not exactly match chlorine and pH to bacteriological results because the technician collects chlorine and pH samples two minutes prior to collecting bacteriological samples. Consequently, the bacteriological samples may be indicative of the distribution system and the chlorine and pH indicative of standing water in building plumbing. Many of the sample point buildings are large multi-storied, barracks type structures. Four minutes may not be a sufficient flush time to be getting distribution system water before taking the sample.

5. Rinse water should meet the criteria in Standard Methods (16) Table 9020I. The BEE has already identified the need for a better method of rinsing the filtration receptacle between samples and has some squirt bottles on order. QA samples of a positive sample followed by a negative sample showed no cross contamination using the "swirl" rinse method.

6. Positive QA/QC samples insure media, incubator, and rinse water will support coliform growth. A positive QA/QC sample followed by a negative QA/QC sample insures no carry-over of contamination from a previous sample. Both are essential to an effective monitoring program.

7. Verification of coliform positive by lactose formation or CO/ONPG insures no positive coliform colonies go undetected and prevents false positive coliforms.

8. Follow-up sampling confirms whether a positive sample was caused by the distribution system rather than other factors. The present rule for following up at the single sample point makes it difficult to eliminate tap contamination or building service connection or a localized cross connection as causes of contamination. EPA eliminated most of the shortcomings in the present follow-up rules effective 31 Dec 90 when they required multiple site resampling.

P. Regulatory and Compliance Issues

1. EPA has developed regulations on a system-by-system basis. Ideally, health officials should consider both US and Panamanian samples when making decisions concerning water quality and public notification. US health officials have clear guidance from EPA. Panamanian health officials share the same concern for insuring potable drinking water. Trying to apply different regulations to the same water system could be impractical, especially in noncompliance cases when EPA requires public notification.

2. Coliform compliance.

a. The regulations written for coliforms do not address the situation in Panama. AF samples for August demonstrate compliance for the Air Force portion of the system. USA samples for August demonstrate noncompliance for the Army portion of the system. PCC monitoring for their portion of the system demonstrates compliance. EPA gives no specific guidance on how to judge compliance when water system monitoring offices use two monitoring techniques, i.e., US uses membrane filter technique and PCC uses the fermentation tube technique.

b. Integral to compliance is public notification and the issue of public health which follows the question, "Is the water potable?" Neither the USA PM activity nor the USAF clinic have documented any increase in illness associated with the detection of coliform in the system. Also significant, there has been no evidence of illness in US Forces TDY to Panama. The TDY population can be as large as 25% of the total AF population. EPA does not require evidence of illness prior to public notification; however, there are cases where EPA and state health officials did not notify the public or require boil water measures when evidence showed no adverse health due to coliforms of the types isolated from the water distribution system (11).

3. Howard AFB is not taking the THM samples EPA requires. Consequently, they do not have data on THM background levels and cannot calculate whether they are in compliance until they take four consecutive samples. Data correlating chlorine levels would be especially helpful in determining how great a chlorine dose the Miraflores Water Treatment Plant can add and allow the system to meet THM standards. Higher chlorine doses (except chloramines) and longer contact times with free available chlorine create higher levels of THMs. The system was very close to the standard of 100 g/l in Nov 88 when one sample showed 93 g/l. Increased chlorine dosage in recent months has probably increased system THM levels.

C. Source of Contamination and Remediation Alternatives

1. Contamination sources. It was not within the scope of the AFOEHL visit to determine with certainty the source of contamination. However, since the source of contamination is relevant to the water's potential for disease and subsequently the need for public notification, etc., a discussion of the likely source(s) of contamination is appropriate.

a. Microorganisms penetrating the filtration process at the Miraflores Water Treatment Plant are a potential source of system contamination.

b. Line infiltration in the 70-plus year-old system is a distinct possibility throughout the system, notwithstanding efforts to maintain pressure at 30-40 psi. Zero or negative pressure occurs routinely on the Clayton water line when switching from plant-supplied water to storage tank-supplied water and infiltration, at least to a limited extent, is certainly occurring.

c. A distribution system biofilm harboring and supporting growth of microorganisms is also likely. Biofilms frequently create conditions where bacteria are detected even with high levels of free available chlorine.

2. Remediation Alternatives

a. High volume bacteriological sampling at the treatment plant effluent will identify whether the treatment plant is contributing to the contamination problem.

b. Inspecting and pressure checking the distribution system will identify infiltration sources of contamination. Damaged lines should be serviced. The PCC should adjust alkalinity to prevent system corrosion. Raising chlorine dosage using chlorine gas reduces pH and consumes system alkalinity making the water more aggressive and creating further damage within the distribution system.

c. Flushing and mechanical cleaning may be effective when the approach is sytematic, i.e., includes the entire system, is repeated periodically, and is thorough enough to prevent regrowth. This approach will cause breaks in the distribution system to occur and temporary degradation in water quality.

d. PCC should consider chloramination as an effective alternative to free chlorine for eliminating contamination caused by biofilms. Costs are roughly 1.7 times higher than free chlorine (13).

IV. RECOMMENDATIONS

A. Bacteriological Sampling

1. Move the munitions maintenance drinking water bacteriological sample to the sink in the administrative building.

2. Use a covered cooler filled with frozen water packs to keep samples cold during sample collection.

3. Review system layout for possible identification of non-looped sample sites on Albrook AFB and Howard AFB. Create additional routine sample sites as near as possible to the entry points to Howard AFB and Albrook AFB.

4. Take Cl and pH samples immediately after taking the bacteriological sample. Evaluate how long a wait is required for each sampling point to obtain the main distribution system water. This can be done by checking for a water temperature change before sampling. The water in the distribution mains should be distinctly cooler than water sitting in the building plumbing.

5. Obtain and begin using standard plastic laboratory squirt bottles for rinsing between samples pending receipt of the sterilizable bottles on order.

6. Continue to run weekly positive samples. In the event the positive sample shows no colonies the local OI should outline a procedure calling for resampling all sample points. A negative control with colony growth is indicative of poor technique. Procedures documented in the local OI should call for resampling and invalidating subsequent positive field samples.

7. Speciate all types of sheen and non-sheen colonies.

8. Modify local procedures to require four repeat samples--upstream within five service connections, downstream within five service connections, at the same tap, and at another tap within the same building. This is one sample more than EPA will be requiring, but it will insure the base can pinpoint the source of contamination with a single round of resampling.

B. Joint and Combined Actions

1. US and Panama Canal Officials should develop an agreement on joint monitoring of the system, analytical procedures, joint health surveillance of water-borne illness, and issuance of public notifications. We recommend a memorandum of understanding concerning to what extent the PCC intend to comply with the existing and proposed regulations for drinking water. A substantial agreement on this point should be possible now since EPA has written or proposed all the foreseeable, major drinking water legislation.

2. AF should institute a QA measure to periodically invite USA PM laboratory technicians to conduct AF water samples using the AF water laboratory and procedures. USA may want to consider a reciprocal arrangement.

3. US and PCC officials should develop an agreement on joint sampling procedures and data sharing for determining compliance. Failing that, and in the interim, USAF and USA monitoring officials should meet monthly to evaluate whether the US portion of the distribution is in compliance.

4. USAF and USA medical personnel should monitor water-borne illness trends. Until coliform levels in the portions of the system monitored by US forces comply with the MCL, recommend USAF Clinic and USA PM provide analytical and epidemiological data to SOUTHCOM and HQ TAC medical personnel for review on a monthly basis. Recommend the decision level for public notification be vested in SOUTHCOM medical staff with HQ TAC coordination. This approach is consistent with the United States EPA and State review structure for stateside water problems.

C. Total Trihalomethane Sampling

Howard AFB BEE take four THM samples beginning ASAP IAW the CFR requirements and keep track of system chlorine levels.

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APPENDIX A

Survey Request Letter

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DEPARTMENT OF THE AIR FORCE

24TH MEDICAL GROUP (TAC)
APO MIAMI 34001-5000

REPLY TO ATTN OF: SGPB (Capt Harvey, AV284-4701) 30 Aug 90

SUBJECT: Priority Request for Occupational and Environmental Health Laboratory (OEHL) Drinking Water Survey

TO: HQ TAC/SGPB
USAF OEHL/CC
INTURN

1. Request Maj Garland, AFOEHL/ECQ, perform a drinking water quality survey at Howard AFB and Albrook AFS. Recent bacteriological sampling by the Air Force and Army suggest that the water system is contaminated, however, finding the source of contamination is beyond our capability. Maj Garland was consulted about our situation and is aware of the problem. An Army Environmental Hygiene Agency survey team will be here during 4 - 14 Sep 90, request Maj Garland's assistance during that time.

2. Direct any further questions to Capt Lana Harvey at AV 284-4701.

A. FELIX MEYER, III, Colonel, USAF, MSC
Commander

cc: AFSC/SGP

1st IND, HQ TAC/SGPB 04 SEP 1990

TO: USAF OEHL/CC

Request your support for this priority survey at Howard AFB, Panama. We have discussed this problem with Maj Garland on several occasions and he is fully aware of the circumstances surrounding the survey. If possible, Maj Garland should be on site during the AEHA survey. Your timely assistance would be greatly appreciated. Please refer questions directly to the BEE at Howard, Capt Harvey, DSN: 284-4701.

WILLIAM B. TATE, LtCol, USAF, MC
Director, Professional Services
Office of the Command Surgeon

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APPENDIX B

Howard AFB Bacteriological

Monitoring Record

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Sample #	Location Sample Site	Date Time of Collection	Date Time of Analysis	pH Level	Free Avail. Chl.	Tech	Total Coliform	Remarks
187	Pre Control	NA	22Aug90	–	–	[illegible]	Ø	
188	Post Control	NA	" 1200 "	–	–	[illegible]	Ø	
189	Post Treat Plt.	22Aug 1130	22Aug 1200	?	?	[illegible]	TNTC	Positive Samp. Confirmed
190	Pre Control	–	27 Aug 1431	–	–	[illegible]	Ø	
191	Kobbe Bohio	27 Aug 1300	27 Aug 1431	6.8	3.0	[illegible]	Ø	No Growth
192	Kobbe "849"	27 Aug 1315	27 Aug 1431	6.8	3.0	[illegible]	Ø	
193	Post Control	–	27 Aug 1431	–	–	[illegible]	Ø	
194	Pre Control	29 Aug 9[illegible]	29 Aug 1310	–	–	[illegible]	Ø	
195	Bldg 91 [illegible]	29 Aug 1125	29 Aug "	6.8	3.0	[illegible]	Ø	
196	Bldg 706 "	29 Aug 1110	29 Aug "	7.4	2.8	[illegible]	Ø	
197	Bldg 850 [illegible]	29 Aug 1030	29 Aug "	6.8	3.0	[illegible]	Ø	
198	Qtrs 259 "	29 Aug 1045	29 Aug "	7.0	3.0	[illegible]	Ø	
199	Post Control	29 Aug [illegible]	29 Aug "	–	–	[illegible]	Ø	
200	Positive Sample	29 Aug [illegible]	29 Aug "	–	–	[illegible]	TNTC	50:50 Solution
201	Control	6 Sept 90 1300	6 Sept 90	~~7.6~~	~~1.0~~	gh	Ø	
202	Munition Maint	0958		7.6	1.0	gh	Ø	Red (1) [illegible]
203	Bowling Center	0911		6.8	2.5	gh	Ø	Red (1) [illegible]
204	PMEL (Albrook)	1033		7.4	3.0	gh	Ø	
205	Q-46	0930		6.8	2.5	gh	Ø	Red (1) [illegible]
206	Q-5 (Albrook)	1020		6.8	2.5	gh	Ø	
207	Control	1330		–	–	gh	Ø	
208	Positive	6 Sept 90 1050		–	–	gh	20	5ml to 95ml distilled

– Remarks only reflect Green Sheen colonies
red colonies may not be [illegible]

	Samp #	Location	Date Collected	Date Analyzed	Ph.	Chl.	Col/100ml	Tech	Remarks
SPECIAL SAMPLING	158	Curundu 1996A	3 Aug 90	3 Aug 90	1.0	7.2	Ø	RB	Analysis Prev. Med. Corozal
	159	Curundu Elem. Sch.	3 Aug 90	3 Aug 90	0.4	7.2	Ø	RB	"
	160	Bldg 95 Clayton	3 Aug 90	3 Aug 90	~~2.2~~	6.8	Ø	RB	"
	161	Pre Control	~~NA~~	3 Aug 90	7.2	—	Ø	RB	"
	162	Post Control	~~NA~~	3 Aug 90	7.2	—	Ø	RB	"
b.	163	Positive Samp.	~~NA~~	3 Aug 90	—	+	+	RB	Pink colonies
	164	Bowling Ctr	9 Aug	9 Aug 90	1.5	6.8	Ø	RB	—
	165	Offrs Qtrs	9 Aug	9 Aug 90	1.5	7.0	Ø	RB	Acinetobacter 1 pink Col
*	166	Mun. fons	9 Aug	9 Aug 90	1.5	7.0	Ø	RB	Acinetobacter 2 pink Col.
	167	Bo 1162	9 Aug	9 Aug 90	1.5	7.0	Ø	RB	—
	168	PMEZ	9 Aug	9 Aug 90	1.5	7.2	Ø	RB	Acinetobacter 3 pink col.
	169	QTRS 5 Alb.	9 Aug	9 Aug 90	1.5	6.8	Ø	RB	—
	170	Pre Control	—	9 Aug 90	—	—	Ø	RB	—
Special Samples	171	Post Control	—	9 Aug 90	—	—	Ø	RB	—
	172	Positive Ctrl.	—	9 Aug 90	—	—	24	RB	Green Slater
	173	Corozal (Comm	15 Aug	15 Aug 90	6.8	3.0	Ø	RB	Army/PCC
	174	Albrook 333B	15 Aug	15 Aug 90	7.2	2.8	Ø	RB	1st Tap of Tank
	175	Clayton Inf. PUMP	15 Aug	15 Aug 90	6.8	2.8	Ø.	RB	Army/PCC
	176	Albrook Offr Ell	15 Aug	15 Aug 90	6.8	2.8	Ø	RB	Routine Samp (Tank)
>	177	Fleet Services	15 Aug	15 Aug 90	7.2	.0	Ø.	RB	
	178	Pre Control	—	15 Aug 90	—	—	Ø	RB	
	179	Post Control	—	15 Aug	—	—	Ø	RB	
	180	Positive Samp.	~~15 Aug~~	15 Aug	—	—	TNTC	RB	Pink Colonies
	181	House 649 How	22 Aug 90	22 Aug 90	6.9	2.5	Ø	RB	
	182	House 1541 How	22 Aug 90	22 Aug 90	6.8	3.0	Ø	RB	
	183	House 127 Albk	22 Aug 90	22 Aug 90	6.8	2.8	Ø	RB	
Tank Sampling	184	House 282 Albk	22 Aug 90	22 Aug 90	7.0	2.5	Ø	RB	~~Albrook~~
	185	IDMI Tank Sample	22 Aug 90	22 Aug 90	6.8	3.0	Ø	RB	Chlorinated by Inlongond
	186	T...	...		6.8	2.8			

Sample #	Location	Date Collected	Date Analyzed	pH	Chl.	Col.	Tech	Remarks
132	Q-450 Ft Kobb.	27 Jul 90	27 Jul 90	7.0	1.5	Ø		
133	Q-438 Ft Kobbje			7.0	1.5	Ø		
Control #2	—			—	—	Ø		
Positive	Ditch			-	-	Ø		2 drops
Positive	Ditch			-	-	Ø		.5 ml
Control #1	# 134	30 Jul 90	30 Jul 90	—	—	Ø		Rumat Corz Lab.
#135	Kobbe Q-449			6.8	1.5	Ø		
#136	Amador D'Club			6.8	1.5	Ø		
#137	Q Hedgmts D'C			6.8	1.0	Ø		
#138	Curundu Cafeteria			6.8	1.0	Ø		
#139	Curundu Quarters			6.8	.8	Ø		
#140	Curundu School			6.8	.2	Ø		
#141	Clayton B-95			6.8	1.5	Ø		
Control #2	#142			—	—	Ø		
#143	Positive			—	—	Ø		
#144	Post Control	2 Aug 90	2 Aug 90	—	—	Ø		
145	Q 46A Hou.			6.8	1.5	Ø		
146	Albrook Mainst.			7.4	1.0	Ø		
147	Bowling Ctr Alb.			7.1	1.5	Ø		
148	Q 5			7.1	1.0	Ø		
149	Pilot			7.1	1.5	Ø		
150	Post Control			—	—	Ø		
151	Positive			—	—	2		
152	HAFB Clinic	3 Aug 90	3 Aug 90	0.0	7.2	Ø		PREVIOUS ANALYSIS CORRECT
153	Kobbe 440A	3 Aug 90	3 Aug 90	1.2	7.0	Ø		"
154	HAFB Front Gate	3 Aug 90	3 Aug 90	1.0	6.9	Ø		"
155	Ft Am C Club	3 Aug 90	3 Aug 90	1.2	6.9	Ø		"
156	Quarry Hts C Club	3 Aug 90	3 Aug 90	1.2	6.8	Ø		"
157	Curundu Gate	3 Aug 90	3 Aug 90	1.0	6.8	Ø		"

SPECIAL NON-HAFB

Base Sample#	Location	Date Collected	Date Analysis	pH	Chl.	Col	Tech	Remarks
115	Corz. Gate House	25Jul90	25Jul90	6.8	2.0	0	gal	
116	QHeight Gate H.	25Jul90	25Jul90	7.1	25.	0	gal	
117	B-250 Alb.	25Jul90	25Jul90	7.0	2.5	0	gal	
Positive	Ditch	25Jul90	25Jul90	—	—	0	gal	
Control#2	—	25Jul90	25Jul90	—	—	0	gal	
Control#1		26Jul90		—	—	0	gal	
118	Corz.			6.8	2.5	0	gal	
119	Q-239 Alb.			6.8	2.0	0	gal	
120	B-250 Alb.			6.8	2.0	0	gal	
121	B 706 Howard			7.0	2.0	0	gal	
132	Q-91 Howard			6.8	2.0	0	gal	
123	QHeights			7.0	2.0	0	gal	
Control#2				—	—	0	gal	
Positive	2drops			-	-	45 on plate	gal	
Positive	5ml			-	-	25 on plate	gal	
Positive	10ml			-	-	TNTC	gal	
~~Control#1~~	~~Enter to Curundu to Cafeteria~~ Curundu	27Jul90						
Control#1 (PCC)	— Enter to Curundu	27Jul90	27Jul90	—	—	0	gal	
134	(next to cafeteria)	27Jul90	27Jul90	7.2	1.5	0	gal	
135	Amador O'C			~~6.8~~ 2.8	2.0	0	gal	
136	Quarry Heights O'Club			6.8	1.5	0	gal	
137	Curundu School Next to Gym			7.1	0.4	0	gal	
138	Clayton B-95			6.8	2.2	0	gal	
139	Curundu House 1996			6.8	1.0	1	gal	
130 PCC	Water Treatment Plant (Clayton Entr.)			6.8	1.5	0	gal	
131	Curundu Cafeteria			6.8	1.0	0	gal	
~~Control#1~~	~~—~~						gal	
~~Positive~~	~~Ditch~~						gal	

APPENDIX C

US Army Preventive Medicine

Bacteriological Monitoring Record

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DATA COMPARISON TABLE

REPORT CLAYTON - NOTE - FAC LEVELS ARE LISTED TO THE RIGHT OF EACH POINT

DATE	BLD 95	ELEM SCHOOL	HOUSING A707	CLAYTON MOV	MOTOR POOL	INFLUENT TANK	HIGH PRESS METER
JUNE 26	POS 1.5	POS 0.7	X	X	X	X	X
JUNE 28	NEG 1.5	NEG 0.5	X	X	X	X	X
JULY 3	POS 1.5	NEG 1.0	X	X	X	X	X
JULY 27 USA	POS 2.2	NEG 0.4	X	X	X	X	X
PAN CANAL	NEG	NEG	X	X	X	X	X
AIR FORCE	NEG	NEG	X	X	X	X	X
JULY 30 USA	NEG 1.5	NEG 0.2	X	X	X	X	X
PAN CANAL	NEG	NEG	X	X	X	X	X
AIR FORCE	NEG	NEG	X	X	X	X	X
JULY 31	POS 1.5	NEG 1.0	X	X	X	X	X
UGUST 2 USA	X	X	X	NEG 1.0	POS 1.0	POS 1.0	X
PAN CANAL	X	X	X	?	?	?	X
AUGUST 7	X	X	X	X	X	POS 2.8	X
AUGUST 9	X	X	X	NEG 2.7	X	NEG 4.0	X
AUGUST 10	X	X	X	POS 2.7	POS 2.5	POS 2.7	X
AUG 15 USA	X	X	NEG 3.0	NEG 2.7	X	NEG 2.7	NEG 2.7
PAN CANAL	X	X	NEG	NEG	X	NEG	NEG
AUG 28 USA	X	X	X	POS 2.7	X	NEG 2.7	POS 2.7
PAN CANAL	X	X	X	NEG	X	NEG	NEG
AUG 29 USA	X	X	X	POS 2.7	X	POS 2.7	X
PAN CANAL	X	X	X	NEG	X	NEG	X

DATA COMPARISON TABLE

FORT AMADOR

DATE	OFFICERS CLUB	GOLF CLUB	NAVAL HOUSING	NAVAL HQ	PCC METER BALBOA E
JUNE 26	POS 0.8	X	X	X	X
JUNE 28	POS 0.8	X	X	X	X
JULY 3	NEG 1.0	X	X	X	X
JULY 27 USA	NEG 2.0	X	X	X	X
PAN CANAL	NEG	X	X	X	X
AIR FORCE	NEG	X	X	X	X
JULY 30 USA	NEG 1.5	X	X	X	X
PAN CANAL	NEG	X	X	X	X
AIR FORCE	NEG	X	X	X	X
JULY 31	NEG 1.0	X	X	X	X
AUG 2 USA	X	NEG 1.0	X	NEG 1.0	NEG 2.0
PAN CANAL	X	NEG	X	NEG	NEG
AUG 15 USA	NEG 2.7	POS 2,7	NEG 3.0	NEG 3.0	X
PAN CANAL	NEG	POS	NEG	NEG	X
AUG 31 USA	X	POS 2.7	X	X	X

AUG 31(FORT AMADOR WAS FLUSHED)

DATA COMPARISON TABLES

QUARRY HEIGHTS

DATE	OFFICERS CLUB	MONTAGUE HALL	EDWARDS PL METER	QTS 7 METER
JUNE 27	POS 1.5	X	X	X
JULY 27 USA	POS 1.6	X	X	X
PAN CANAL	NEG	X	X	X
AIR FORCE	NEG	X	X	X
JULY 30 USA	NEG 1.0	X	X	X
PAN CANAL	NEG	X	X	X
AUG 2	X	X	NEG 1.2	NEG 1.2
AUG 16 USA	X	POS 2.6	NEG 2.7	POS 2.7
PAN CANAL	X	NEG	X	NEG 2.7
AUG 28 USA	X	NEG 2.7	X	POS 2.7
PAN CANAL	X	NEG	X	NEG
AUG 29 USA	X	NEG 2.7	X	NEG 2.7
PAN CANAL	X	NEG 2.7	X	NEG 2.7
SEPT 2	X	X	X	NEG 2.7

DATA COMPARISON TABLE

****

CURUNDU

****

DATE	QTS 1996-A		CAFETERIA		TOWNSITE	
JUNE 26	POS	1,0	POS	1.0	X	
JUNE 28	NEG	0.7	NEG	0.7	X	
JULY 3	POS	1.0	POS	1.0	X	
JULY 27 USA	POS	1.0	POS	1,0	X	
PAN CANAL	NEG		NEG		X	
AIR FORCE	POS		POS		X	
JULY 30 USA	NEG	0.8	POS	0.8	X	
AIR FORCE	X		NEG		X	
JULY 31	POS	0.8	POS	0.8	X	
AUG 15 USA	POS	2,7	X		NEG	3.0
PAN CANAL	NEG		X		NEG	
AUG 28 USA	POS	2.7	POS	2.7	X	
PAN CANAL	NEG		NEG		X	
AUG 29 USA	NEG	2.7	NEG	2.7	X	
PAN CANAL	NEG		NEG		X	
SEPT 2	NEG	2.7	NEG	2.7	X	

DATA COMPARISON TABLES

WEST BANK

DATE	FT. KOBBE A450	HOWARD COMMISSARY	HOWARD MOV	SAN JUAN METER	COCOLI 8" METER
JUNE 28	POS 0.7	X	X	X	X
JULY 10	POS 1.0	X	X	X	X
JULY 17	NEG 1.0	NEG 1.0	X	X	X
JULY 27 USA	NEG 1.5	X	X	X	X
AIR FORCE	NEG	X	X	X	X
JULY 30 USA	POS 1.5	X	X	X	X
PAN CANAL	NEG	X	X	X	X
AIR FORCE	NEG	X	X	X	X
JULY 31	NEG 1.0	X	X	X	X
AUG 2 USA	X	X	X	POS 1.5	X
PAN CANAL	X	X	X	NEG	X
AUG 15 USA	NEG 2.7	NEG 2.7	NEG 2.7	NEG 2.7	NEG 2.7
PAN CANAL	NEG	NEG	NEG	NEG	NEG

Distribution List

	Copies
HQ USAF/SGPA Bolling AFB DC 20332-6188	2
HQ AFSC/SGPB Andrews AFB DC 20334-5000	2
24 Med Grp/SGPB Howard APO Miami 34001-5000	5
US Army Environmental Hygiene Agency/HSHB-ME-W Aberdeen Proving Ground MD 21010-5422	2
HQ TAC/DEM Langley AFB VA 23665-5578	2
HQ TAC/SGPB Langley AFB VA 23665-5578	2
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HQ HSD/XA Brooks AFB TX 78235-5000	2

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